REMARKS

The applicants have studied the Office Action dated April 22, 2004. It is submitted that the application is in condition for allowance. Claims 14, 31, and 32 have been amended and claims 15, 29 and 31 have been canceled without prejudice or disclaimer. Reconsideration and allowance of all of the claims in view of the following remarks are respectfully requested.

Claims 1, 11, and 20 are rejected under 35 USC 102(e) as being anticipated by Takada (US 2002/0155,812 A1). Claims 2-6, 8-13, 15, 17-19, 21-24, 26-28 are rejected under 35 USC 103(a) as being unpatentable over Takada in view of Tolson et al. (GB 2,343,572). These rejections are respectfully traversed.

It is submitted that the Takada reference cannot be a prior art under 35 U.S.C. 102. The Takada reference was filed on September 24, 2001. However, the applicant disclosed his invention to his counsel on January 29, 2001. As a result, the Takada reference cannot be a prior art reference under § 102. A Declaration Under 37 C.F.R. § 1.131 is enclosed to support this fact. Therefore, it is respectfully submitted that the rejections under 35 U.S.C. § 102(e) and 103(a) are now moot.

Claims 14, 29, and 31 are rejected under 35 USC 102(b) as being anticipated by Tolson et al. (GB 2,343,572). The limitations of claims 15 and 32 have been added to claims 14 and 31, respectively. Thus, claims 14 and 31 distinguish over the art of record. Claim 29 has been canceled.

If there are any fees due in connection with the filing of this response, please charge such fees to our Deposit Account No. 17-0026. If a fee is required for an extension of time under 37 C.F.R. 1.136 not accounted for, such an extension is requested and the fee should also be charged to our Deposit Account. A duplicate copy of this page is enclosed.

Respectfully submitted,

Dated: August 3, 2004

By: ______________________
Howard H. Seo, Reg. No. 43,106
Phone No. 858-845-5235

QUALCOMM Incorporated
Attn: Patent Department
5775 Morehouse Drive
San Diego, California 92121-1714
Telephone: (858) 658-5787
Facsimile: (858) 658-2502

Attorney Docket 010139

In Re Application of	)	
	)	**For: DISTORTION REDUCTION IN A WIRELESS COMMUNICATION DEVICE**
Peter Shah	)	
	)	
	)	
Serial No. 10/066,072	)	
	)	
Filed: February 1, 2002	)	**Group No. 2685**

Declaration Under 37 CFR 1.131

The undersigned declares that the applicants disclosed the present invention to their counsel on January 29, 2001 and the application was filed on February 1, 2002. This fact establishes the conception of the invention prior to the effective date of the reference. A copy of the original disclosure is enclosed to support this fact.

Date: Signature: ______________________

Howard Seo, Reg. No. 43,106

To: Peter Shah <pshah@qualcomm.com>
From: JRLupien <jlupien>
Subject: Re: pshah3 NEW DISCLOSURE idf
Cc:
Bcc:
Attached:

Hi Peter:
The new Invention Disclosure entitled "IIP2 enhancement scheme" has been assigned the docket number 010139.

Please include the docket number and title when making future enquiries regarding the disclosure

Thank You
Jean R. Lupien
X15886

At 12:02 PM 1/29/01 -0800, you wrote:

QUALCOMM INVENTION DISCLOSURE FORM

ID NO.: 010139
(pshah3)

The invention herein described was evolved during my the course of my employment, and is being submitted pursuant to the terms of the Employee Agreement signed by me.

1. TITLE OF INVENTION:

IIP2 enhancement scheme

2. PURPOSE OF INVENTION:

Probably the most serious problem in direct down-conversion receivers is IIP2. If the RF signal contains e.g. two jammers with a frequency separation of fs, then second-order distortion will cause a low-frequency product to be generated at frequency fs. In direct down-conversion receivers, the output signal is also at low frequencies (baseband), and the distortion product will therefore contaminate the desired signal. This stands in contrast to super-heterodyne receivers, which convert RF down to an intermediate frequency (IF). Here, the low-frequency distortion products can easily be filtered away.

Since the second-order distortion produces products at the frequency separation, regardless of the

absolute frequency of the jammers, the IIP2 requirements are usually very high for direct-conversion receivers and often the single most difficult parameter to meet.

The present invention describes a way to greatly improve IIP2 of down-conversion mixers.

3. PRIORITY: The priority of this invention is: HIGH

This invention is central to the new RF architecture announced by Qualcomm (the zero-IF architecture). Although we will probably not be using it in the first generation of chipsets (due to schedule concerns), there is a substantial possibility that we will be pursuing it in the future. The IIP2 problem is by far the greatest problem in zero-IF receivers, and given the great cost and area savings that zero-IF promises, it is a hot research topic that most of our competitors are working actively on. The resolution of this problem is key to successfully producing chips using the zero-IF architecture.

I think patenting is quite urgent due to the high research activity in this field.

4. CONCEPTION:
Invention conceived on: 12/27/00
This disclosure written on: 01/29/01

5. REDUCTION TO PRACTICE, if any:
Construction of device started on:
Device reduced to Practice of: 1/6/01
Device completed on:
Device tested on:

6. ENVIRONMENT: Please describe the system or environment in which the invention will be used:

see notebook

7. INFORMATION SOURCES AND RELATED DOCUMENTS: Please list any information sources, standards, etc. that are relevent to understanding your invention.

see notebook.

Also:

"Improved Mixer IIP2 Through Dynamic Matching", Edwin Bautista, Babak Bastani, Joseph Heck, Proceedings of the ISSCC'2000, pp. 376-377.

"System-Level Compensation Approach to Overcome Signal Saturation, DC Offset, and 2nd-Order Nonlinear Distortion in Linear Direct Conversion Receiver", Hiroshi Tsurumi, Miyuki Soeya, Hiroshi

Yoshida, Takafumi Yamaji, Hiroshi Tanimoto, Yasuo Suzuki, IEICE Trans. Electron., vol E82-C, no. 5, May 1999.

8. BACKGROUND AND PRIOR ART: How was the task your invention accomplishes previously performed, prior to the development of your invention?

See notebook and information sources

9. DESCRIPTION: Please describe your invention.

See notebook

10. Was the invention conceived or reduced to practice under:
(a) Government or other contract? no.
Project Name:
Account Charged:

(b) Company funded? yes.
Project Name: ZIF receiver
Account Charged: 71157

11. PAST OR FUTURE PUBLIC DISCLOSURES: Identify any anticipated or past publications, offers for sale, reports, proposals, or other type of disclosure, whether written or oral that will be made outside of the company.

none

12. MISCELLANEOUS COMMENTS:

13. INVENTOR INFORMATION:

Signature Date

Inventor: Peter Shah
Extension: (858) 651 8668
Email: pshah
Ste: BB246C

Signature Date

Inventor:

Extension:
Email:
Ste:

Signature Date

Inventor:
Extension:
Email:
Ste:

Signature Date

Inventor:
Extension:
Email:
Ste:

Signature Date

Inventor:
Extension:
Email:
Ste:

Signature Date

Inventor:
Extension:
Email:
Ste:

14. RECIPIENT:

The invention disclosure was reviewd by me on the date indiated.

Witness Signature Witness Printed Name Date

Witness Signature Witness Printed Name Date

15. ANY ADDITIONAL FILES STORED IN:

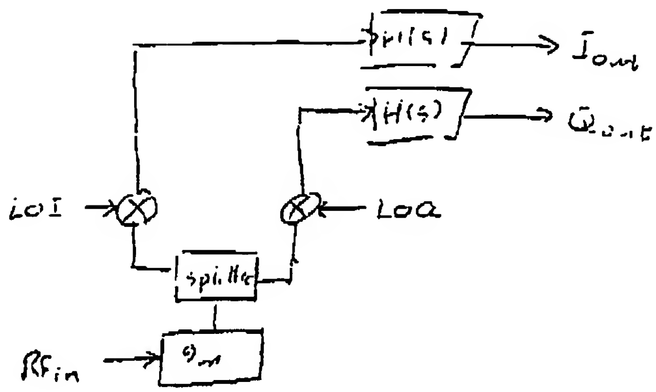
/prj/web/Departments/Legal/Patents/receive/pshah3

END OF DISCLOSURE

IIP2 enhancement scheme

Background.

A standard direct downconversion scheme looks as follows:



where H(s) are jammer rejection filters.

The main problem in this topology is IIP2. If the RF input signal contains jammers at a spacing of $\Delta\omega_j$ then second-order distortion will create a component at frequency $\Delta\omega_j$ in the output signal. If this is inside the channel bandwidth, it could cause unacceptable loss of carrier-to-noise ratio. This will occur regardless of the absolute frequencies of the jammer, as long as they are close enough to each other – only the frequency separation matters. As a result of this, the IIP2 requirements are usually very high.

The main source of IM2 is the mixer cores. This is because any IM2 from the g_m-stage gets mixed away from baseband when it passes through the mixer cores.

In principle the core should not generate any IM2 distortion, because it is symmetrical. However, through simulations it has been found that even very slight asymmetries cause unacceptably low IIP2.

Consequently, device mismatches, layout details, LO impedance and impedance mismatch, as well as LO duty cycle, all have a strong influence on IIP2.

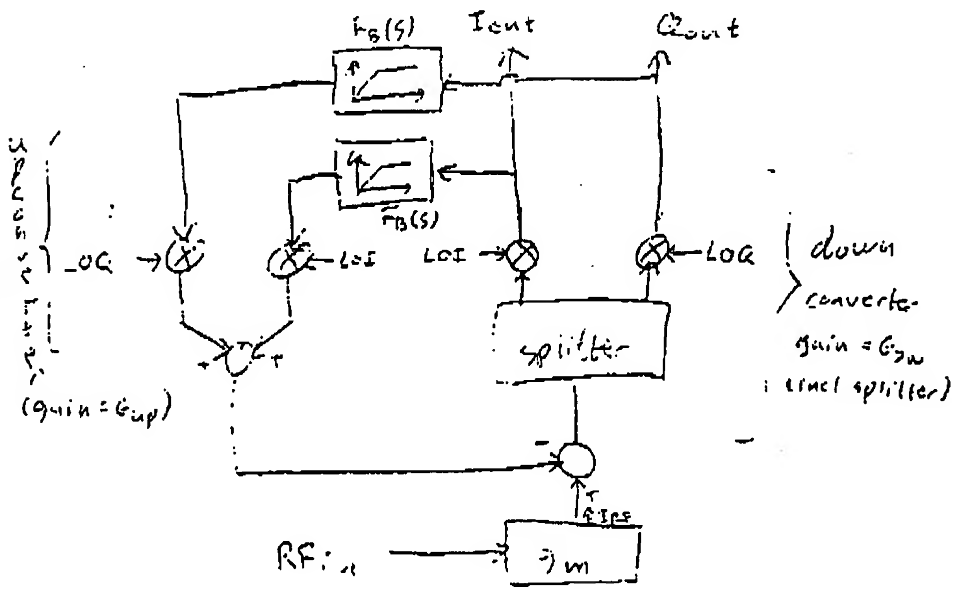
While it may be possible to reestablish symmetry through various calibration schemes, this might prove not to be very robust in high-volume production, due to the very small asymmetries involved in the first place. Also apart from a one-time factory calibration, it is difficult to imagine how the calibration would be performed during normal use. Here, the undesired IM2 products are buried in the desired signal and are thus not directly measurable.

In summary, the IIP2 problem seems to be an especially difficult one, because it depends on very detailed aspects of circuit design, process statistics, and layout, which are difficult to control. For the same reason it does not lend itself easily ~~and~~ robustly to calibration.

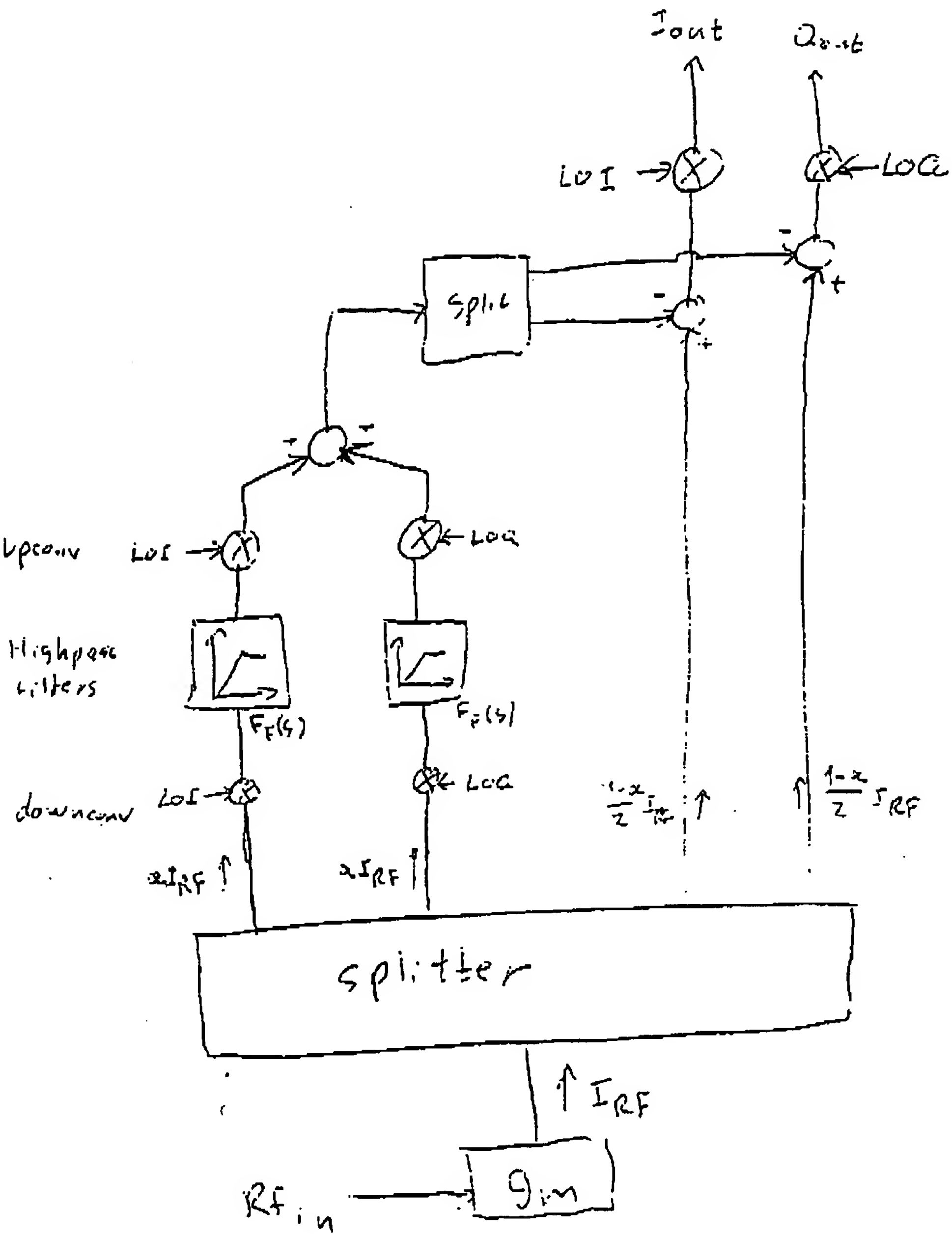
The Idea

Instead of focusing on the nearly intractable asymmetry we attack one of the other root causes of IM2 distortion, namely the obvious one that jammers even enter into the mixer cores in the first place. If there weren't any jammers there wouldn't be any IM2 distortion (and, incidentally, not IM3 either).

This means that it is desirable to move the jammer filtering function H(s) from the output to before the mixer cores. We can achieve that by either a feedback or feedforward approach, as shown below



Feedback approach

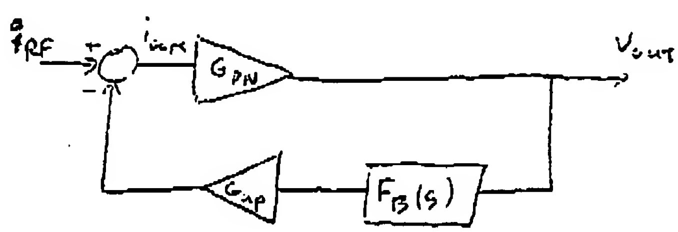


Feedforward approach

Feedback approach

Besides the desired signal, the downconverter also mixes jammers down to baseband. So if we pass the output signal through highpass filters $F_B(s)$, we obtain a measure of the jammers. We then upconvert the jammers back to RF and subtract them in front of the mixer core. This way we effectively cancel the jammers before they enter into the core. Notice also that IM2 products from the upconverter are non-critical because they lie far away from the RF freq.

Small-signal model:



$$\frac{V_{out}}{i_{RF}} = \frac{G_{DN}}{1 + G_{DN} G_{up} F_B(s)}$$

(here i_{RF} and i_{core} are the baseband equivalents of the actual signal currents)

$$\frac{i_{core}}{i_{RF}} = \frac{1}{1 + G_{DN} G_{up} F_B(s)}$$

If $H(s)$ is the desired baseband filtering, we have:

$$H(s) = \frac{1}{1 + G_{DN} G_{up} F_B(s)}$$